Getting Glucose to Goal in the Hospital Setting

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Getting Glucose to GOAL In the Hospital

Objectives:

- Discuss the importance of inpatient glucose control.
- Describe the goals of care
- Describe basal bolus insulin therapy
- Discuss appropriate insulin therapy considerations for a variety of situations.

Glucose Management and Hospitalized Patients

- In hospitalized patients with critical illness, hyperglycemia is a signal that warrants our attention.
- “Body on FIRE”
Hospitals and Hyperglycemia—What’s the Big Deal?

- Hyperglycemia is associated with increased morbidity and mortality in hospital settings.
  - Acute Myocardial Infarction
  - Stroke
  - Cardiac Surgery
  - Infection
  - Longer lengths of stay

Stress response and hyperglycemia

Metabolic and Hormonal Changes Leading to Stress Hyperglycemia

- Gluocorticoids
- Growth hormones
- Inflammatory cytokines

Hyperglycemia:

- Immune dysfunction
- Hemodynamic effects
- Tissue effects

Stress, multiple organ failure and death

Hyperglycemia*: A Common Comorbidity in Medical-Surgical Patients in a Community Hospital

- Normoglycemia
- Known Diabetes
- New Hyperglycemia

n = 2,020

Hyperglycemia: Fasting BG ≥ 126 mg/dl or Random BG ≥ 200 mg/dl X 2

Umpierrez et al, J Clin Endocrinol Metab 87:978, 2002
Hyperglycemia in Patients With Undiagnosed Diabetes

- Hyperglycemia in 38% of pts admitted to hospital
- 26% had known history of diabetes
- 12% had no history of diabetes
- Mortality rate – non dx, dx and no diabetes
  - 1.7% - pts without diabetes
  - 3% - pts dx with diabetes
  - 16% - hyperglycemia, undiagnosed or treated
- All hospital patients screened for hyperglycemia?


Effect of Hyperglycemia on Hospital Mortality

![Graph showing mortality rates for different groups: Normoglycemia, Known diabetes, New hyperglycemia.](Umpierrez GE et al. J Clin Endocrinol Metab. 2002;87:978-982.)

- *P<.01 compared with normoglycemia and known diabetes.

Management of Inpatient Hyperglycemia and Diabetes in Older Adults

- Hospitalization 3.1 times higher for all people with diabetes (compared to those without)
- Diabetes increases with age:
  - 65-75 yrs, 20% with diabetes
  - 80 yrs plus, 40% with diabetes
- Inpatients over the age of 65
  - 70% in critical care and cardiac surgery are hyperglycemic (BG > 140)
  - 30% of general medicine and surgery are hyperglycemic

Guadillero E. Umpierrez, and Francisco J. Pasquel Dia Care 2017;40:509-617
Causes of Inpatient Hyperglycemia

- Pre-existing Type 1 or Type 2
- Discovered diabetes / prediabetes
- Holding of usual diabetes med(s)
- Infection, Cardiac events
- Admin of agents that cause hyperglycemia
  - Steroids
  - Enteral or parenteral nutrition
  - Vasopressors (epi)

ADA/AACE Goals and Treatments For Hospitalized Patients

ADA Goals: If BG 180 +
- Start subq insulin
- Blood glucose goals 140-180
- Individualize based on pt status
- Basal /bolus Insulin preferred
- Insulin drip preferred treatment

AACE Goals:
- Before meal < 140
- After meal <180

Consensus: Inpt Hyperglycemia, Endocr Pract. 2009;15 (No.4)
Glucose Goals – Clinical judgement required

- More relaxed BG goals
  - Terminally ill
  - At risk of hypo due to other health issues
  - In setting where intensive checks not feasible

- When setting goals consider:
  - Clinical status
  - Severity of illness
  - Nutritional status
  - Glucose variability and trends
  - Pt’s usual management plan and expertise

Type 1 in Hospital

- 43 yr old admitted to evaluate angina.
- Morning blood sugar is 142.
- You walk in with his insulin dose.
- The patient says, “I will bottom out if I take that much insulin.”
- “That dose won’t touch my blood sugar”

What do you say?

Poll question 1

- PZ is admitted for CHF. Creat 1.4. On Metformin 1000 mg BID at home. How would his diabetes best be managed in hospital setting according to ADA Standards?
  - A. Keep him on metformin
  - B. Hold metformin and start sliding scale insulin
  - C. Keep metformin add basal insulin
  - D. Hold metformin, start basal-bolus therapy
Diabetes Med Management in Hospital - ADA

- Incorporate electronic insulin order sets
- The sole use of Sliding Scale insulin is discouraged
- For discharge, oral meds can be resumed

Start Basal/bolus therapy
- NPH and Regular insulin
- Long-acting and rapid-acting insulin
- Premixed insulin

Studies are looking at Basal plus DPP-IV for older clients

Poll Question 2

- Nurse walks into patients room to give his Type 2 pt 10 units of regular insulin. Pt weighs 70 kg and is almost 6 feet tall. Pre meal BG is 88. What is this pt at risk of?
  A. infection due to chronic hyperglycemia
  B. hyperglycemia since there is no basal insulin
  C. severe stress response
  D. hypoglycemia due to over insulinization

Hypoglycemia – Focus on Prevention

- Defined as BG < 70
- Clinically Significant Hypo < 54

- If BG < 100, consider adjusting insulin / meds
- If BG < 70, insulin change required

- Need hypoglycemia treatment policies / action
- Need hypo Prevention Policies.
Steps to Prevent Hypo

- Prior episode predicts future episode
- Basal insulin causes 78% of hypo.
  - Need action to decrease basal dose
- If fasting BG < 100, lower basal insulin
- If renal failure, conservative insulin dose
- Patient has N/V or not consistent eater?
  - Give bolus insulin after meals or use hs scale
- Anticipate events that put pt at risk of hypo:
  - NPO for surgery, decreasing steroid dose,
    improving infection, recovering after cardiac event
- Strive to admin the least amount of insulin
  necessary to reach glycemic targets

Life Study – Mrs. Jones

Mrs. Jones is 62 years old, a little heavy and complains of feeling tired
and urinating several times a night. Admitted with a foot infection.
Her WBC is 12.3, glucose 237. She has HTN and history of GDM.
No ketones in urine.

- What risk factors and signs of diabetes does she have?
- What type of diabetes does she have?

Life Study – Mrs. Jones

- How would we manage her BG in hospital?
- What kind of education would we provides?
Blood Glucose Above 140 – Take Action

- Any blood glucose above 140
  - Check A1c (if no documented result over past 3 months)
  - If BG ≥ 180 – start insulin therapy

Pre Diabetes criteria:
- Fasting Glucose = 100-125mg/dl
- A1c 5.7 – 6.4%

Diabetes criteria:
- Fasting Glucose = 126 mg/dl +
- Random Glucose = 200 mg/dl +
- A1c 6.5% +

How Much Insulin Does a Patient Need?

- It depends, based on:
  - Body weight
    - Overwt, normal wt, or thin
  - Frail, elderly
  - Eating status
    - Normal, poor intake or NPO
  - Renal or hepatic insufficiency
  - Type of Diabetes
  - Current meds; steroids, insulin, oral DM agents
  - Infected or Septic

Insulin Therapy Components

- Basal insulin – long acting insulin covers between meals and through night
- Prandial or meal insulin – a bolus insulin that covers food, IV dextrose, enteral nutrition, TPN or other nutritional supplements
- Correction insulin – bolus insulin dosed to correct for hyperglycemia that occurs despite use of basal and prandial insulin
  - Usually given before meals w/ prandial insulin
Getting Glucose to Goal – How?

Subq insulin therapy (oral agents stopped)
- Determine insulin needs based on wt/BG
  - 0.4 units kg/day if BG 140-200mg/dl
  - 0.5 units kg/day if BG 201-400mg/dl
- 50% of total dose - Basal Insulin (eg Lantus, NPH)
  - Increased by 20% if fasting BG elevated
  - Reduced for fasting BG <70mg/dl
- 50% of total dose Bolus Insulin (eg Reg, Lispro) divided evenly into 3 meals
  - If premeal BG elevated, increased bolus dose

Ms. Jones is 60kg – What insulin dose?
Basal/Bolus Insulin Dosing Strategy

50/50 Rule
- 0.3-1.0 units/kg day
  - Basal = 50% of total
    - Glargine at HS
      - NPH or Detemir BID
  - Bolus = 50% of total
    - usually divided into 3 meals

Example – You Try
- Wt 60 kg x 0.5 = ___ units of insulin/day
  - Basal dose: ____ units
    - Glargine ____ units HS
      - NPH/Detemir ____ BID
  - Bolus dose: ____ units
    - ____ units Reg, NovoLog, Apidra, Humalog each meal

Poll Question 3
Based on Mrs. Jones body wt of 60kg, how much bolus insulin would she need per meal?
- A. 3 units per meal
- B. 5 units per meal
- C. 15 units at hs
- D. 3-5 units per meal
Now that we covered food, what about BG > 150?

- That’s where the Correction Bolus comes into play.

<table>
<thead>
<tr>
<th>Sample Correction Bolus</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rapid/Fast Acting Insulin (1 unit: 50 mg/dl &gt; 150)</strong></td>
</tr>
<tr>
<td>70 or less</td>
</tr>
<tr>
<td>71-150 mg/dl</td>
</tr>
<tr>
<td>151-200 mg/dl</td>
</tr>
<tr>
<td>201-250 mg/dl</td>
</tr>
<tr>
<td>251-300 mg/dl</td>
</tr>
<tr>
<td>301-350 mg/dl</td>
</tr>
<tr>
<td>351-400 mg/dl</td>
</tr>
</tbody>
</table>

Important Insulin Concepts

- **Basal Plus trial**
  - Single daily dose of glargine plus correction doses of rapid-acting insulin resulted in similar improvement in glycemic control and no difference in hypoglycemia compared with a standard basal-bolus regimen.
  - Basal-plus-correction regimen may be preferred for patients with poor or no oral intake
  - Insulin regimen with basal, nutritional (basal-bolus), and correction preferred for patients with good intake

- **Patients treated with insulin prior to admission**
  - Take total daily insulin dose at home:
    - Give half as long-acting basal insulin
    - Give half as prandial insulin.
    - Reduce dose by 20% to 25% to prevent hypoglycemia, particularly in those with poor or uncertain caloric intake.  

Umpierrez and Lansang, Cleveland Clinic 2016
Physician Order Entry

- Insulin should be administered using validated written or computerized protocols
- Allow for predefined adjustments in insulin dosage based on glycemic fluctuations

Insulin Scale at Local Hospital

<table>
<thead>
<tr>
<th>BG mg/dL</th>
<th>Mild Scale</th>
<th>Moderate Scale</th>
<th>Aggressive Scale</th>
<th>Custom Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>70-100</td>
<td>2 units</td>
<td>3 units</td>
<td>4 units</td>
<td>units</td>
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<td>101-200</td>
<td>3 units</td>
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<td>5 units</td>
<td>units</td>
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<tr>
<td>301-400</td>
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<td>6 units</td>
<td>7 units</td>
<td>units</td>
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<tr>
<td>401-500</td>
<td>6 units</td>
<td>7 units</td>
<td>8 units</td>
<td>units</td>
</tr>
<tr>
<td>&gt; 500</td>
<td>units</td>
<td></td>
<td></td>
<td>0 units</td>
</tr>
</tbody>
</table>
Chart Audit Results

2017–July, Aug, Sept

- 50 charts audited – 1067 fingersticks
- All pts w/ diagnostic code 250.00-250.99 (anywhere in diagnosis)
- Retrospective randomized electronic chart audit
- LOS > 3 days, < 20
  - Avg LOS = 6 days (last year 5 days)

Blood Glucose Goals and Results

<table>
<thead>
<tr>
<th>PreMeal Goal &lt; 140</th>
<th>Post Meal Goal &lt; 180</th>
</tr>
</thead>
<tbody>
<tr>
<td>We achieved this goal</td>
<td>We achieved this goal</td>
</tr>
<tr>
<td>• 2017 – 38%</td>
<td>• 2017 – 63%</td>
</tr>
<tr>
<td>• 2016 – 46%</td>
<td>• 2016 – 67%</td>
</tr>
<tr>
<td>• 2015 - 42%</td>
<td>• 2015 - 52%</td>
</tr>
</tbody>
</table>

No BG less than 40.

Average Blood Glucose

<table>
<thead>
<tr>
<th>Premeal BG Goal: 80 - 140</th>
<th>HS BG Goal: 80 - 180</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg Premeal BG = 171</td>
<td>Avg HS BG = 176</td>
</tr>
<tr>
<td>• 2017 - 171</td>
<td>• 2017 - 176</td>
</tr>
<tr>
<td>• 2016 - 155</td>
<td>• 2016 - 163</td>
</tr>
<tr>
<td>• 2015 - 164</td>
<td>• 2015 - 167</td>
</tr>
</tbody>
</table>
Low Blood Glucose Distribution

<table>
<thead>
<tr>
<th></th>
<th>2017</th>
<th>2016</th>
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</thead>
<tbody>
<tr>
<td>&lt;40</td>
<td>2*</td>
<td>3</td>
</tr>
<tr>
<td>40-49</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>50-59</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>60 – 70</td>
<td>17</td>
<td>14</td>
</tr>
</tbody>
</table>

*Not secondary to insulin -

Causes of Hypo - Main Categories

- Admitted with hypo
- Poor PO intake
- Too much basal
- On oral meds + Insulin
- Insulin Scale Mismatch
- Hypo due to other causes

Admitted with Hypoglycemia

- PY – 37, 45, 48 - Osteomyelitis, NPO, hypo not associated with insulin
- DC- 39 on admit (on glimepiride 2mg)
Hypo associated with poor intake
- MS – gave 2 units insulin, no dinner, pm BG 113, am BG 67 – Mild scale, Avg bg 137
- RA – 67, 64 – mild scale, not eating well (avg bg 117)
- CH – 55 at hs – on agg scale at dinner, ate only 50%

Hypoglycemia Due to Lantus
- RR – 47- At HS 52 units Lantus, BG AM before 103
- PG – 59 (am low due to 6 units Glargine – am BG less than 100 4 days, Glargine not decreased)
- SH – AM Lows; 68, 55, 61, 49. Lantus at 17 units, decreased to 12 than 5 units
- SB – 64 in am (34 units Lantus night before)
- JW – AM 61- On glargine 10 units, decreased to 6 units – AM BG improved

Hypoglycemia due to Oral Meds?
- MW – 68, 66, 65 (pt on metformin and sitagliptin) Mild to aggressive
- MF – 48, 69 – On aggressive scale + amaryl and pioglitazone
- DE – BG 60s from MN to 07 – Given 80 units Lantus night before. Also on glimepiride 4 mg daily. Lantus decreased to 70 units.
Hypo due to Insulin Scale Mismatch

- FR – 55 (aggressive scale)
- VH – 61 (aggressive scale)
- DB – 67 and 69 during stay (mismatch insulin and food). Mod to mild. 162 lbs
- KH – 54 (on aggressive, poor intake, decreased to moderate)

Questions for Group

- Should we d/c oral meds on admission, especially sulfonylureas?
- Should we consider more conservative approach to basal insulin?
- If pt not eating well, should we consider using hs scale? Starts at 250

28 Hypos – Half no documented treatment

- No treatment documented 50% of time
- These were the hypo BG Values:
  - 43, 45, 54, 55, 59, 61, 64, 66, 67, 68, 68, 69, 69
- Recheck time varied from 9 minutes to 4 hrs
Life Study – Mrs. Jones

- What kind of education would we provide?
- Going home with new diabetes and foot infection

Is Inpatient Diabetes Education Realistic?

- Unique opportunity to address urgent learning needs
- Brief and targeted education effective
- Strategies
  - Empathic listening and open ended questions
  - "What are you most worried about when it comes to taking care of your diabetes.
- Assist w/ needed supplies and referrals

General Recommendations

- Diabetes discharge planning starts on admit
- Type of DM clearly identified / documented
- Check A1c in hospital:
  - If no A1c available for past 3 months
  - Present with hyperglycemia and no DM history
- Pts with new hyperglycemia need appropriate follow-up testing care and testing at d/c
Topics to Cover in Hospital

- Survival Skills
  - Diabetes, self-monitoring, BG Goals
  - Hypo & Hyper – recognition, treatment and prevention
  - Healthy eating
  - Meds- how to take, potential side effects and action
  - Proper use and disposal of needles and syringes
- ID of health care provider for post d/c care
  - Schedule for f/u visit within 1 month
  - Parameters of when to call for help
    - Sick days, N/V, if BG < 70 or > 300

MNT In Hospital Setting

- Goal of MNT
  - Optimize glycemic control
  - Adequate calories for metabolic demands
  - Create meal plan guidelines for post discharge
- Consistent Carb Meal plan most common
- RD responsible for integrating pts clinical condition to determine a realistic plan for MNT
- RD referral inpt > outpt

Bedside Glucose Monitoring

- Point of Care (POC) monitoring used to guide insulin dosing.
- Do not share finger-stick lancing devices.
- POC monitors have ± 20% error rate (FDA guidelines)
- Eval pts symptoms and/or recheck may be necessary if BG result in question.
Mrs. Jones on Insulin - Now What?

- Nurse had an emergency and pt already ate lunch?
- Nurse administered insulin and pt only ate a few bites of turkey and drank non sugar tea?
- You just gave 3 units of Novolog and patient needs to go to OR NOW!

Poll Question 4

- Nurse gave 3 units aspart (Novolog) insulin and pt needs to go to OR now!
  - Best action?
    - A. Call OR and tell them to postpone surgery
    - B. Give the patient 4 ounces of juice
    - C. Push 1 amp of D50
    - D. Hang IV of 5-10% Dextrose and alert anesthesia

Mrs. Jones needs to go to surgery

- In spite of antibiotics, her foot ulceration isn’t improving.
Preparation for Surgery

- Try to schedule surgery in am, resume meds/insulin when eating and stable.
- **Oral medications**: Hold morning dose. If on sulfonylurea, may need to hold night before
- **Basal Insulin**:
  - for type 2s, give 50%-100% of usual am/pm basal dose
  - for type 1s give 100% of basal dose (individualize)
- **Bolus insulin**: Use mild insulin bolus coverage for type 1 and type 2’s

Getting Mrs. Jones Ready for Discharge

- Mrs. Jones is improved and ready to go home.
- What glucose management strategies for home?
  - Her A1c = 7.9%

Medication Reconciliation

- Pts meds must be cross-checked to make sure no chronic meds were stopped
- Ensure the safety of new prescriptions
- New or changed prescriptions reviewed with pt/ family before discharge
- Avoid complex insulin regimens for those with limited cognition
  - As pt heals, remind them that they may need less insulin / diabetes meds to control BG
- Supplies for insulin administration
Mrs. Jones Discharge Teaching

- What supplies will she need?
- What top 3 things do we need to teach her?
- What resources can we provide?
- What referrals?

Mr. K admitted with Pneumonia

- Waistline 46”, wt 100 kg
- Creat 0.9
- Pneumonia
- Asthma
- Admit Meds
  - Metformin 500 BID
  - Empagliflozin (ran out)
  - Glipizide (worried about hypo)
  - Prednisone 5mg daily
- A1c 10.8%

Basal/Bolus Insulin

Dosing Strategy 0.5 u/kg

50/50 Rule
- 0.3-1.0 units/kg day
- Basal = 50% of total
  - Glargine at HS
  - NPH or Detemir BID
- Bolus = 50% of total
  - divided into 3 meals

Example – You Try
- Wt 100 kg x 0.5 = ___ units of insulin/day
- Basal dose: _____ units
  - Glargine _____ units HS
  - NPH/Detemir ____ BID
- Bolus dose: _____ units
  - NovoLog, Apidra Humalog each meal
Poll Question 5

Mr K. weighs 100kg. Using the basal bolus therapy formula, what would be his basal dose?

- A. 13 units NPH BID
- B. 50 units Lantus (glargine)
- C. 8 units bolus at each meal
- D. 25 units regular insulin

Resistant Correction Bolus

Rapid/Fast Acting Insulin

<table>
<thead>
<tr>
<th>70 or less</th>
<th>Treat for hypo, hold dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>71-150 mg/dl</td>
<td>0 units</td>
</tr>
<tr>
<td>151-200 mg/dl</td>
<td>3 units</td>
</tr>
<tr>
<td>201-250 mg/dl</td>
<td>6 units</td>
</tr>
<tr>
<td>251-300 mg/dl</td>
<td>9 units</td>
</tr>
<tr>
<td>301-350 mg/dl</td>
<td>12 units</td>
</tr>
<tr>
<td>351-400 mg/dl</td>
<td>15 units</td>
</tr>
</tbody>
</table>

Increased Prednisone to 60mg

- Blood glucose levels running 400-500.
BG Running High?

- Possible Causes
  - Glucose Toxic
  - Infection
  - Steroids
  - Physical stress
  - Insulin dose too low

BG Too High?

**Insulin Adjustment Strategies**

- Meal Blood glucose too high?
  - Increase prandial dose by 2 units and/or
  - Increase correction scale by 1-2 units
- Morning blood glucose > 140?
  - Increase evening basal by 10%
- Identify cause
- Consider insulin drip

Mr. K BG Levels Too High

**Insulin Drip Started**

- 100 units insulin in 100 cc NS Bag
- 1 cc = 1 unit of insulin
- Rate based on body wt:
  - 0.05 units/kg per hour
  - 100kg x 0.05 = 5 units insulin/hr
- Rate based on BG / 100
  - BG 400 / 100
  - 4 units insulin / hr
- Monitor BG q 1-2 hr and adjust per protocol
The Ideal IV Insulin Protocol

- Easily ordered (signature only).
- Effective (gets to goal quickly).
- Safe (minimal risk of hypo)
- Easily implemented
- Able to be used hospital wide
- Protocol available electronically

Breaking down Barriers to Implementing Insulin Infusion

- Ongoing staff education
- Passion about importance of glucose management
- Hypoglycemia prevention plan
- Encourage forethought and trouble shooting
- Discuss transitioning from drip to injections
  - Must inject sub q insulin one hour before stopping insulin drip

Dr. Goldberg et al. Diabetes Spectrum - Selling Root Canals: Lessons Learned From Implementing a Hospital Insulin Infusion Protocol. 2005

Prep for Discharge - Mr. K

- Waistline 46”, wt 100 kg
- Creat 0.9
- Pneumonia resolved
- Asthma
- D/C Diabetes Meds
  - Metformin 1000 BID
  - 70/30 Insulin
    - 20 units am
    - 10 units pm
  - BG Monitoring 3 x a day
Discharge Teaching

- What supplies will he need?
- What top 3 things do we need to teach him?
- What resources can we provide?
- What referrals?

Strategies to Improve Inpatient Glucose Control in Hospital Setting

- Standardized bolus / basal scales
- Enhanced RD/ PharmD roles to determine insulin needs
- Dedicated inpatient Diabetes Specialists
- Evidence based IV insulin drip protocols
- Computerized MD order sheets
- A trained interdisciplinary team
- Nursing involvement and buy-in
- Staff education and adequate staffing

Hospital Recommendations

- A1c’s on Admit for known Patients with Diabetes.
- Patients new to Hyperglycemia have F/U Diagnostic Testing with PCP.
- Have an established hyper/hypoglycemia protocol in place.
- Educate, Educate, Educate.
- Start insulin drips as needed
**Diabetes Care in Hospital, Nursing Home and Skilled Nursing Facility**

- Start discharge planning on admission
- Avoid sole use of sliding scale insulin during hospital stay
- Clearly identify type of diabetes on admission
- Critically ill patient goals:
  - Start insulin if BG >180
  - Goal BG 140-180 (some pts may benefit from 110-140)
- Non Critically Ill patient goals
  - Premeal < 140
  - Post meal <180
- Basal bolus preferred treatment
- Have hypoglycemia protocol
- Get A1c on all patient with DM/hyperglycemia

**Summary**

- Hyperglycemia is a marker of metabolic dysregulation and deserves our attention.
- Glucose control improves outcomes.
- Insulin drips and basal bolus regimes are two strategies to improve glucose.
- Inpatient glucose control is cost effective.
- We can make a difference.

**Thank You**

- Questions?
- Email
  bev@diabetesed.net
- Web
  www.DiabetesEd.net